

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)	PATENT APPLICATION
)	
Inventor: Bruce D. Ulrich)	
)	
Serial No.: 09/822.093)	Attorney Docket No.
)	SLA 0494
Filed: March 30, 2001)	
)	Group Art Unit 2877
Title: X/Y ALIGNMENT VERNIER)	
AND METHOD OF)	Examiner: not yet assigned
FABRICATING SAME)	

**CERTIFICATE OF MAILING BY "EXPRESS MAIL"
UNDER 37 C.F.R. § 1.10**

"Express Mail" mailing label number ET841643749US
Date of Mailing : November 15, 2002

I hereby certify that this correspondence is being deposited with the United States Postal Service, utilizing the "Express Mail" Post Office to Addressee" service addressed to Box DAC, Commissioner for Patents, Washington, DC, 20231 and mailed on the above Date of Mailing with the above "Express Mail" mailing label number.

Matthew D. Rabdau

Matthew D. Rabdau
Signature Date: November 15, 2002

PETITION TO WITHDRAW HOLDING OF ABANDONMENT

Box DAC
Hon. Commissioner for Patents
Washington, D.C. 20231

Sir:
Applicant has not yet received a Notice of Abandonment.

However, a Notice to File Corrected Application Papers dated 05/09/2001

06/12/2003 TLWU11 00000008 191457 09822093

01 FC:1460 130.00 CH

SLA0494

was received by Applicant, and Applicant failed to respond to this Notice. Applicant advances to two alternative approaches for allowing this application to be taken up for the first Office action. First, Applicant contends that the Notice to File Corrected Application Papers was improper and that any holding of abandonment should be withdrawn. Second, that any delay in responding to the Notice to File Corrected Application Papers was unintentional, such that any holding of abandonment should be withdrawn, or the application should be revived, if the holding of abandonment is not withdrawn.

On November 12, 2002, I, Matthew D. Rabdau, attorney-of-record in the above identified application, was preparing a status inquiry related to the above identified application, since no response had been received from the Patent Office in over 18 months. Upon review of the file, it was discovered that the last correspondence received from the Patent Office was a Filing Receipt dated 05/09/2001. A Notice to File Corrected Application Papers was attached to the Filing Receipt. A copy of the Filing Receipt along with the Notice to File Corrected Application Papers is attached as Attachment A.

On November 13, 2002, I called the Customer Service Center at the OIPE to determine the status of the application. I was informed that it was in abandonment processing, but that a Notice of Abandonment had not yet been sent. It was indicated that a Petition to Withdraw

Holding of Abandonment would be an appropriate action, since the Notice of Abandonment had not yet been sent. Accordingly, this Petition to Withdraw Holding of Abandonment is being submitted.

The Notice to File Corrected Application Papers Was Improper and the Holding of Abandonment Should Be Withdrawn

The Notice required:

- Substitute drawings in compliance with 37 CFR 1.84 because:
 - more than one figure is present and each figure is not labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (A, B, etc.)(see 37 CFR 1.84(u)(1));

A response to this requirement is attached, including substitute drawings as required by the Notice, as Attachment B.

However, upon reviewing the basis for the requirement to file substitute drawings and the drawings originally submitted along with the application, it appears that this Notice was excessive.

There were 7 sheets of informal drawings originally submitted with the application, which is attached as Attachment C. The sheets of informal drawings are numbered "Sheet 1 of 7" through "Sheet 7 of 7."

- Sheet 1 of 7 contained a single figure identified as "FIG. 1."
- Sheet 2 of 7 contained two figures identified as "FIG. 2" and "FIG. 3."
- Sheet 3 of 7 contained two figures identified as "FIG. 4" and "FIG. 5."
- Sheet 4 of 7 contained three figures identified as "FIG. 6", "FIG. 7" and "FIG. 8."
- Sheet 5 of 7 contained 4 figures identified as "FIG. 9", "FIG. 10", "FIG. 11" and "FIG. 12."
- Sheet 6 of 7 contained a single figure identified as "FIG. 13."
- Sheet 7 of 7 also contained a single figure identified as "FIG. 13."

The rejection is apparently based on the presence of two figures identified as "FIG. 13." Applicant does not deny that this is a technical violation of 37 CFR § 1.84(u)(1).

However, MPEP § 608.02(a) states that:

"Utility and Design applications should be taken up for the first Office action without a request for corrected drawings unless the informal drawings are so unclear that they do not facilitate an understanding of the invention as to permit examination of the application."

The drawings are quite clear, and generally well labeled. They may even be acceptable as formal drawings with very minor modifications. Based upon the presence of the sheet numbers designating "Sheet 6 of 7" for the first "FIG. 13" and "Sheet 7 of 7" for the second "FIG. 13," it should be immediately clear that the second "FIG. 13" is clearly intended to be "FIG. 14" The two figures are very similar. They are examples of the

same X/Y Alignment Vernier in two different states of alignment. The first "FIG. 13", on Sheet 6 of 7, is in proper alignment as noted by item 112 being centered within the vernier. The second "FIG. 13", on Sheet 7 of 7 is slightly out of alignment as noted by the item 112 being positioned down and to the right of center. A quick review of the Brief Description of the Drawings would further clarify any possible confusion. The Brief Description of the Drawings lists figures as "Fig. 1" consecutively through "Fig. 14." The Brief Description of the Drawings identifies "Fig. 13" and "Fig. 14" as follows:

"Fig. 13 is a plan view showing an active layer overlying a reference layer in perfect alignment.

Fig. 14 is a plan view showing an active layer overlying a reference layer in an out of alignment condition."

Although OIPE would not be expected to review the entire specification, the description of FIG. 13 and FIG. 14 running from page 11, line 17 through page 12, line 18 would further clarify the proper identity of the figures. An Examiner, or anyone of ordinary skill in the art reviewing the patent application, when published, would have no difficulty in properly identifying the figures described and in understanding the application as submitted.

Since the figures would permit examination of the application, the requirement for substitute drawings prior to passing the application to examination was excessive in this case. Accordingly, Applicant respectfully requests withdrawal of any holding of abandonment.

**Any Delay in Submitting Substitute Drawings in Response to the
Notice to File Corrected Application Papers was Unintentional**

In the event that the holding of abandonment is not withdrawn as requested, please consider this a Petition to Revive an Unintentionally Abandoned Application Under 37 CFR § 1.137(b).

A response, including the substitute drawings required by the Notice to File Corrected Application Papers is attached as Attachment B. The failure to respond to the Notice to File Corrected Application Papers on or before July 9, 2001, and the entire delay up to the filing of this petition, were unintentional under 37 CFR § 1.137(b).

A Notice of Abandonment has not been received, as the application is apparently in Abandonment Processing, based upon a telephone call placed to OIPE. Since no notice of abandonment has been received, the date of abandonment is presumably July 10, 2001.

Because this petition is possibly more than one year after the presumed date of abandonment (July 10, 2001), Applicant additionally submits further information as to when Applicant's representative first became aware of the situation, and a showing as to how the delay occurred despite due diligence on the part of Applicant's representative.

In the course of preparing a status inquiry, I discovered that a Notice to File Corrected Application Papers had been included with the Filing Receipt. There was no indication in the file that this Notice had been responded to. A review of the docketing system revealed that there

had been no entry made for the two month due date to respond to the Notice to File Corrected Application Papers.

A review of our records indicates that this was likely the first Notice to File Corrected Application Papers to have been received by our office. Subsequently, procedures were put in place to look for and to docket Notices to File Corrected Application Papers.

As such, Applicant's attorney hereby requests revival of this application, if deemed abandoned, because the failure to respond to the Notice to File Corrected Application Papers was unintentional.

Conclusion

Applicant hereby requests the withdrawal of any holding of abandonment in this application, or revival of the application if abandoned, and further requests that the application be taken up for the first Office action.

Applicants have attached the following:

- Attachment A: A copy of the Filing Receipt with accompanying Notice to File Corrected Application Papers.
- Attachment B: A response to the Notice to File Corrected Application Papers, including substitute drawings.
- Attachment C: A copy of the original application as filed, including drawings.

Should there be any questions, please call Mr. Rabdau at
(360) 834-8567.

The Commissioner is hereby authorized to charge Deposit
Account No. 19-1457 for any petition fees or other charges associated with
this communication, including a petition fee of \$1,280.00 under 37 CFR §
1.17(m), if necessary. Should any additional charges be required in
future, please charge any additional fees associated with this
communication, or credit any overpayment, to Deposit Account
No. 19-1457. A duplicate copy of this authorization is enclosed.

Respectfully submitted,

Date: 11/15/2002

By: Matthew D. Rabdau
Matthew D. Rabdau
Reg. No. 43,026

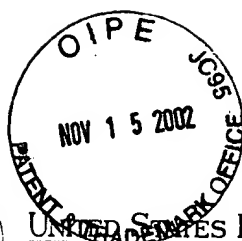
Matthew D. Rabdau, Patent Attorney
Sharp Laboratories of America, Inc.
5750 NW Pacific Rim Blvd.
Camas, WA 98607

Telephone: (360) 834-8567
Facsimile: (360) 817-8505



Attachment A

The following is a copy of the Filing Receipt with accompanying Notice to File Corrected Application Papers.

Page 1 of 4
RECEIVED**MAY 15 2001**

UNITED STATES PATENT AND TRADEMARK OFFICE

DCR PATENT COUNSEL

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
09/822,093	03/30/2001	2877	818	SLA 0494	7	26	3

CONFIRMATION NO. 9061

Mathew D. Rabdau
Patent Attorney
Sharp Laboratories of America, Inc.
5750 NW Pacific Rim Boulevard
Camas, WA 98607

FILING RECEIPT

OC000000006055728

Date Mailed: 05/09/2001

Receipt is acknowledged of this nonprovisional Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Customer Service Center. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).**

Applicant(s)

Bruce D. Ulrich, Beaverton, OR;

Domestic Priority data as claimed by applicant**Foreign Applications****If Required, Foreign Filing License Granted 05/07/2001****Projected Publication Date:** To Be Determined - pending completion of Corrected Papers**Non-Publication Request:** No**Early Publication Request:** No**Title**

X/Y alignment vernier and method of fabricating same

Preliminary Class

356

Data entry by : IBRAHIM, SADIE

Team : OIPE

Date: 05/09/2001

**LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15**

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Office of Export Administration, Department of Commerce (15 CFR 370.10 (j)); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

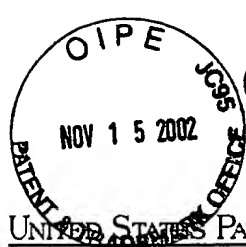
No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PLEASE NOTE the following information about the Filing Receipt:

- The articles such as "a," "an" and "the" are not included as the first words in the title of an application. They are considered to be unnecessary to the understanding of the title.
- The words "new," "improved," "improvements in" or "relating to" are not included as first words in the title of an application because a patent application, by nature, is a new idea or improvement.
- The title may be truncated if it consists of more than 500 characters (letters and spaces combined).
- The docket number allows a maximum of 25 characters.
- If your application was submitted under 37 CFR 1.10, your filing date should be the "date in" found on the Express Mail label. If there is a discrepancy, you should submit a request for a corrected Filing Receipt along with a copy of the Express Mail label showing the "date in."
- The title is recorded in sentence case.

Any corrections that may need to be done to your Filing Receipt should be directed to:

Assistant Commissioner for Patents
Office of Initial Patent Examination
Customer Service Center
Washington, DC 20231



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/822,093	03/30/2001	Bruce D. Ulrich	SLA 0494

CONFIRMATION NO. 9061

FORMALITIES LETTER



OC000000006055729

Mathew D. Rabdau
Patent Attorney
Sharp Laboratories of America, Inc.
5750 NW Pacific Rim Boulevard
Camas, WA 98607

Date Mailed: 05/09/2001

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

This application has been accorded an Application Number and Filing Date. The application, however, is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a)

The required item(s) identified below must be timely submitted to avoid abandonment:

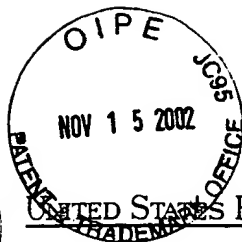
- Substitute drawings in compliance with 37 CFR 1.84 because:
 - more than one figure is present and each figure is not labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (A, B, etc.)(see 37 CFR 1.84(u)(1));

*A copy of this notice **MUST** be returned with the reply.*

Customer Service Center

Initial Patent Examination Division (703) 308-1202

PART 1 - ATTORNEY/APPLICANT COPY



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
09/822,093	03/30/2001	Bruce D. Ulrich	SLA 0494

CONFIRMATION NO. 9061

FORMALITIES LETTER



OC000000006055729

Mathew D. Rabdau
Patent Attorney
Sharp Laboratories of America, Inc.
5750 NW Pacific Rim Boulevard
Camas, WA 98607

Date Mailed: 05/09/2001

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

This application has been accorded an Application Number and Filing Date. The application, however, is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given **TWO MONTHS** from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a)

The required item(s) identified below must be timely submitted to avoid abandonment:

- Substitute drawings in compliance with 37 CFR 1.84 because:
 - more than one figure is present and each figure is not labeled "Fig." with a consecutive Arabic numeral (1, 2, etc.) or an Arabic numeral and capital letter in the English alphabet (A, B, etc.)(see 37 CFR 1.84(u)(1));

*A copy of this notice **MUST** be returned with the reply.*

Customer Service Center

Initial Patent Examination Division (703) 308-1202

PART 2 - COPY TO BE RETURNED WITH RESPONSE

Attachment B

The following is a response to the Notice to File Corrected Application Papers, including substitute drawings.



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)	PATENT APPLICATION
)	
Inventor: Bruce D. Ulrich)	
)	
Serial No.: Not Yet Assigned)	Attorney Docket No.
)	SLA 0494
Filed: Herewith)	
)	Group Art Unit 2811
Title: XY ALIGNMENT VERNIER)	
AND METHOD OF)	Examiner:
FABRICATING SAME)	

**TRANSMITTAL IN
RESPONSE TO NOTICE TO FILE CORRECTED
APPLICATION PAPERS**

Hon. Commissioner for Patents
Washington, D.C. 20231

Sir:

The undersigned, attorney-of-record in the above-identified application, herewith sends substitute drawings to replace sheet 6 of 7 and sheet 7 of 7, which corresponds to two figures identified as Fig. 13, with replacement figures Fig. 13 and Fig. 14. The typographical error identifying the figure on sheet 7 of 7 as "Fig. 13" instead of "Fig. 14" is the apparent basis for the Notice to File Corrected Application Papers.

An additional copy of Fig. 14 is provided to show the change made in red, specifically the replacement of the numeral "3" with the numeral "4" in the identification of Fig. 14.

A copy of the Notice to File Corrected Application Papers, dated May 09, 2001, accompanies this Transmittal.

X

The Commissioner is hereby authorized to charge any fees associated with this communication to Deposit Account No. 19-1457. A duplicate copy of this authorization is enclosed.



Respectfully submitted,

Date: 11/15/2002

By: Matthew D. Rabdau

Matthew D. Rabdau
Reg. No. 43,026

Matthew D. Rabdau, Patent Attorney
Sharp Laboratories of America, Inc.
5750 N.W. Pacific Rim Highway
Camas, WA 98607
Telephone: (360) 834-8567
Facsimile: (360) 817-8505



Attachment C

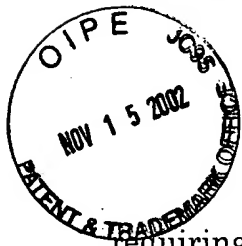
The following is a copy of the original application as filed, including drawing sheets 1 of 7 through 7 of 7.



X/Y ALIGNMENT VERNIER AND METHOD OF FABRICATING SAME

Invented by
Bruce D. Ulrich

X/Y ALIGNMENT VERNIER AND METHOD OF FABRICATING SAME



BACKGROUND OF THE INVENTION

This invention relates generally to manufacturing processes requiring lithography, and more particularly to an X/Y vernier for
5 ascertaining misalignment of a lithographic step relative to an underlying pattern.

Lithography has a broad range of industrial applications, including the manufacture of integrated circuits, flat-panel displays, and micromachines.

10 The lithographic process transfers a mask, or reticle, pattern onto a substrate. Usually, the pattern is formed in a photoresist layer overlying the substrate. The pattern may then be etched into a material underlying the photoresist layer. For example, in the case of inlaid copper, copper is deposited into trenches formed by the etch step and then
15 polished using CMP to form the desired copper lines. This layer will include a reference pattern. A second device layer to be formed will be patterned using photoresist. The second layer will include an active pattern in addition to the desired device related features. Prior to completion of the process associated with the second device layer, the
20 photoresist pattern is compared to the underlying reference pattern to confirm alignment, or measure misalignment.

Referring now to Fig. 1 (prior art), a typical vernier 10 is shown. The vernier is comprised of two patterns aligned adjacent to each other. The first pattern 12, which is also called the reference pattern, is
25 assimilated into the substrate, or an overlying layer, depositing material, by etching, or otherwise delineating the pattern. The second pattern 14,

which is also called the active pattern, is a layer of photoresist that has been patterned. This vernier could be used, for example, to check the alignment during the formation of multiple metal layers. It is necessary to check the alignment of the second pattern 14 relative to the first
5 pattern 12 prior to continuing with the subsequent process steps. If the alignment is beyond a predetermined tolerance, the second pattern 14 can be removed and redone, prior to additional processing. The alignment may be checked by viewing the pattern under a microscope.

A proper alignment would be shown by proper alignment of
10 the first centerline 16, and the second centerline 18. As shown in Fig. 1 (prior art) the patterns are out of alignment as the two most apparently aligned features are reference pattern mark 20 and active pattern mark 22. If this misalignment were outside of an acceptable range, the second pattern would have to be removed, re-exposed, and re-checked. If the
15 wafer is not reworked while out of alignment there a significant likelihood of producing a wafer with poor yield.

A disadvantage of this type of vernier is that only one direction is available for inspection at a time. As shown in Fig. 1 (prior art) only the x-direction can be determined. A second vernier, rotated
20 90-degrees relative to the one shown, will need to be provided in order to inspect alignment along the y-direction. Although these verniers are usually formed within a scribe sheet, in order to avoid interference with device structures, they may not be easy to find. The x-direction and the y-direction may be a relatively large distance from each other. Even if the
25 x-direction and y-direction are in close proximity, it will require reading two verniers to determine proper alignment in both axes. This wastes time during inspections, and may slow wafer fab processing. In some

cases where the vernier is not within a scribe line, it may also waste valuable wafer area that could be used for constructing devices.

SUMMARY OF THE INVENTION

A two-dimensional vernier formed on a substrate is provided.

5 The vernier comprises a first two-dimensional array of spaced shapes and a second two-dimensional array of spaced shapes overlying the first two-dimensional array of spaced shapes. The first two-dimensional array has a first distance across each shape and a first distance between adjacent shapes. The first two-dimensional array has a first pitch defined by the
10 first distance across each shape and the first distance between adjacent shapes. The second two-dimensional array has a second distance across each shape and a second distance between adjacent shapes. The second two-dimensional array has a second pitch defined by the sum of second distance across each shape and the second distance between adjacent
15 shapes. The second pitch is different from the first pitch and this difference determines the resolution of the vernier.

The vernier can be symmetrical in the x-axis and the y-axis having the same number, size and spacing of shapes in both axes. Alternatively, the vernier may be asymmetrical with a different number,
20 size or spacing of shapes in one direction versus another.

In addition to the two arrays of shapes, the vernier may further comprise measurement guides. The measurement guides may include centerline marks, direction marks, both positive and negative, and alignment marks. The measurement guides are preferably formed
25 adjacent to the first array of spaced shapes. Alternatively, the

measurement guides are formed adjacent to the second array of spaced shapes.

The first array of spaced shapes may be patterned as either a dark field pattern, in which spaced shapes appears bright, or a light field pattern, in which the spaced shapes appear dark. Likewise the second array of spaced shapes can be either dark field or light field regardless of whether the underlying first array of spaced shapes is dark field or light field.

A method of forming the vernier described above comprises the steps of forming a reference pattern on the substrate. This step of forming the reference pattern on the substrate may be accomplished by etching the substrate, or by depositing a material over the substrate and etching the material. The reference pattern preferably includes the first array of spaced shapes and the measurement guides. Following the step of forming the reference pattern, a step of depositing a layer of photoresist over the reference completed. Then, the photoresist is patterned to produce an active pattern, which comprises the second array of spaced shapes.

The two-dimensional vernier may be used to readily determine misalignment of two patterns formed over a substrate in two dimensions simultaneously, that is without looking at two different verniers. A method of determining misalignment between two patterns formed over a substrate comprising the steps of: positioning a two dimensional vernier under a microscope, determining an alignment region, identifying a pair of overlapped shapes that are most fully aligned, and ascertaining the position of the pair of overlapped shapes.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 (prior art) is a plan view of a one dimensional vernier.

Fig. 2 is a plan view of a reference layer with a light field.

Fig. 3 is a plan view of an active layer light field.

5 Fig. 4 is a plan view of a reference layer with a dark field.

Fig. 5 is a plan view of an active layer with a dark field.

Fig. 6 is a cross-sectional view of a reference layer that is flat.

10 Fig. 7 is a cross-sectional view of a reference layer that is indented.

Fig. 8 is a cross-sectional view of a reference layer that is raised.

Fig. 9 is a cross-sectional view of an active layer overlying the reference layer of Fig. 6.

15 Fig. 10 is a cross-sectional view of an active layer overlying the reference layer of Fig. 7.

Fig. 11 is a cross-sectional view of an active layer overlying the reference layer of Fig. 8.

20 Fig. 12 is a cross-sectional view of an active layer with a dark field overlying the reference layer in Fig. 6.

Fig. 13 is a plan view showing an active layer overlying a reference layer in perfect alignment.

Fig. 14 is a plan view showing an active layer overlying a reference layer in an out of alignment condition.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 2 and Fig. 3, a two dimensional vernier, also referred to as an x/y vernier, is provided. A first part of the vernier, a reference pattern 50, is shown in Fig. 2. The reference pattern 50
5 comprises a first array of shapes 52. In addition, x-axis measurement guides 53 (indicated by a dotted line) and y-axis measurement guides 54 (indicated by a dotted line) may be added adjacent the first array of shapes 52. Each set of either x-axis measurement guides 53, or y-axis measurement guides 53 comprise a set of centerline marks 55, a set of
10 negative direction marks 56, a set of positive direction marks 58, and miscellaneous alignment marks 60, which may be used to indicate acceptable ranges of misalignment. The various alignment marks are preferable, but are not necessary to the formation or use of the vernier. The first array of shapes 52 is shown as small squares. They may be any
15 desired shapes but squares or circles are preferable.

Fig. 3 shows a second part of the vernier, an active pattern 64. The active pattern 64 comprises a second array of shapes 66. Just as with the first array of shapes 52, the second array of shapes 66 is shown as small squares. As discussed above, other shapes may be used including
20 circles. The second array of shapes 66 need not be comprised of the same shapes as those used for the first array of shapes. As shown, there are no alignment marks on the active pattern 64. It is possible to incorporate measurement guides into the active pattern 64, either in addition to, or instead of, the x-axis measurement guides 53 and the y-axis measurement
25 guides 54 incorporated into the reference pattern shown in Fig. 2.

The vernier is formed by delineating the reference pattern 50 onto the substrate, or a layer overlying the substrate, and superimposing

the active pattern 64 over the reference pattern 50 by patterning the active pattern 64 into an overlying photoresist layer.

The design of the vernier will now be discussed. Referring again to Fig. 2, the total distance across the reference pattern 50 is shown at 70 as D_{ref} . Reference linewidth, L_{ref} , is shown at 72. Reference spacewidth, S_{ref} , is shown at 74. Reference pitch, P_{ref} , is shown at 76. The reference pitch is equal to the sum of the reference linewidth and the reference spacewidth ($P_{ref} = L_{ref} + S_{ref}$). The reference center, C_{ref} , 78 is shown as corresponding to the reference linewidth, L_{ref} . The reference center, C_{ref} , 78 may correspond to the reference spacewidth, S_{ref} , where the number of shapes on a given axis are even, instead of odd.

The number of shapes, N , that traverse the vernier is an integer value.

$$N = (D_{ref} + C_{ref})/P_{ref}$$

where C_{ref} equals L_{ref} or S_{ref} . For example referring to Fig. 2, where N equals 11, L_{ref} equals S_{ref} , and C_{ref} equals L_{ref} , it is possible to solve for the distance across D_{ref} .

$$D_{ref} = 21 \times L_{ref}$$

So, if the linewidth L_{ref} equals 3 micrometers, the total distance across the vernier, D_{ref} , will be 63 micrometers.

Referring again to Fig. 3, the total distance across the active pattern 64 is shown at 80 as D . Active linewidth, L , is shown at 82. Active spacewidth, S , is shown at 84. Active pitch, P , is shown at 86. The active pitch is equal to the sum of the active linewidth and the active spacewidth ($P = L + S$). The active center, C , 88 is shown as corresponding

to the active linewidth, L. The active center, C, 88 may correspond to the active spacewidth, S, where the number of shapes on a given axis are even, instead of odd.

5 The most important aspects of the vernier, are the vernier resolution, Res, and the vernier range, Range. The resolution is defined as the smallest unit of distance of misalignment that can be determined with the vernier and is equal to the difference between the reference pitch and the active pitch.

$$\text{Res} = |P - P_{\text{ref}}|$$

10 The range of the vernier is defined as the maximum misalignment that can be determined.

$$\text{Range} = \text{Res} \times (N-1)$$

The range and the resolution of the vernier can be independently designed. For a given resolution, the range can be increased by increasing N. N may be increased without needing to increase the distances across either vernier, D_{ref} or D. For a given range, the resolution can be adjusted
15 by controlling the relative pitches between the reference pattern and the active pattern.

As shown the reference pattern 50 and the active pattern 64 are symmetrical, having the same D_{ref} or D for both the x-direction and the y-direction. Although a symmetrical pattern is generally preferred, in
20 some applications an asymmetrical pattern may be used for example one direction could be longer than another, have a different resolution, or a different range than the other.

The reference pattern 50 shown in Fig. 2 is referred to as a light field because the array of shapes 52 are viewed as dark on a light

background. Fig. 4 shows a reference pattern 50 with the opposite polarity, also referred to as a dark field. Likewise, Fig 3 showed an active pattern 64 with a light field. Fig. 5 shows an active pattern 64 with a dark field. Depending upon the materials being used and the method
5 selected to delineate either the reference pattern 50 or the active pattern 64, any combination of light field or dark field arrangements can be used. The reference pattern can be dark field or light field. The active pattern can be dark field or light field, regardless of the polarity of the underlying reference pattern.

10 Fig. 6 shows a cross section of a portion of the reference pattern 50 formed using an underlying substrate 92. The portion of the reference pattern 50 comprises two adjacent shapes 94. The adjacent shapes 94 correspond to individual shapes within the first array of shapes 52. As shown in Fig. 6, the adjacent shapes 94 are level with an upper
15 surface of the substrate. This is a typical arrangement following CMP. For example, in the case of copper metal lines, copper will be inlaid and then polished.

 Fig. 7 shows a cross section of a portion of the reference pattern 50 formed using an underlying substrate 92. The portion of the
20 reference pattern 50 comprises two adjacent shapes 94. The adjacent shapes 94 correspond to individual shapes within the first array of shapes 52. As shown in Fig. 7, the adjacent shapes 94 are etched into the substrate 92. Etching is a common method of patterning a wide variety of materials used in the semiconductor industry.

25 Fig. 8 shows a cross section of a portion of the reference pattern 50 formed using an underlying substrate 92. The portion of the reference pattern 50 comprises two adjacent shapes 94. The adjacent

shapes 94 correspond to individual shapes within the first array of shapes 52. As shown in Fig. 8, the adjacent shapes 94 are formed by depositing a material overlying the substrate 92 and patterning it. Deposition and patterning, by etching, are common methods of producing semiconductor
5 device structures.

Fig 9 shows a portion of the active pattern 64 overlying the portion of the reference pattern 50 shown in Fig. 6. The portion of the active pattern comprises overlying shapes 100. The overlying shapes 100 correspond to individual shapes within the second array of shapes 66. As
10 shown in Fig. 9, the overlying shapes 100 are formed by depositing photoresist and patterning to form the overlying shapes 100. The overlying shapes 100 have an upper surface 102 that is relatively flat, because the overlying shapes are overlying adjacent shapes 94 that are level with the upper surface of the substrate.

Fig 10 shows the portion of the active pattern 64 overlying the portion of the reference pattern 50 shown in Fig. 7. The portion of the active pattern comprises overlying shapes 100. The overlying shapes 100 correspond to individual shapes within the second array of shapes 66. As
15 shown in Fig. 10, the overlying shapes 100 are formed by depositing photoresist and patterning to form the overlying shapes 100. The upper surface 102 of the overlying shapes 100 are not flat, because the overlying shapes are overlying adjacent shapes 94 that are etched, and the overlying shapes follow the contour of the underlying adjacent shapes 94.
20

Fig 11 shows the portion of the active pattern 64 overlying the portion of the reference pattern 50 shown in Fig. 8. The portion of the active pattern comprises overlying shapes 100. The overlying shapes 100 correspond to individual shapes within the second array of shapes 66. As
25

shown in Fig. 11, the overlying shapes 100 are formed by depositing photoresist and patterning to form the overlying shapes 100. The upper surface 102 of the overlying shapes 100 are not flat, because the overlying shapes are overlying adjacent shapes 94, are deposited and etched to produce positive relief, and the overlying shapes follow the contour of the underlying adjacent shapes 94.

Fig 12 shows the portion of the active pattern 64 overlying the portion of the reference pattern 50 similar to that shown in Fig. 9 but with a dark field. The portion of the active pattern comprises overlying shapes 100. The overlying shapes 100 correspond to individual shapes within the second array of shapes 66. As shown in Fig. 10, the overlying shapes 100 are formed by depositing photoresist and patterning to form the overlying shapes 100. However, in this case the overlying shapes 100 are formed as trenches by etching into the photoresist, which remains to act as the dark field. Dark field active patterns can also be used with reference patterns shown in Fig. 10 and Fig. 11.

Fig. 13 shows a top view of the active pattern 64 overlying the reference pattern 50. Following formation of the reference pattern 50 the active pattern 64 is overlaid on it. An operator can view the complete vernier through a microscope. The operator looks down at the vernier and sees a view similar to that shown in Fig. 13. As shown in Fig. 13 the alignment is essentially perfect. The active pattern 64 is aligned over the reference pattern 50 such that the region of apparent optimum alignment of the first array of shapes and the second array of shapes is in an apparent alignment region 110. More specifically optimum shape alignment is apparent at a pair of overlapped shapes 112. Since overlapped shapes 112 are in line with the centerline marks in both the x-

axis and the y-axis the patterns are properly aligned. The operator is able to determine the alignment by looking at a single vernier and determining x and y alignment, without the need to significantly reposition the microscope.

5 Fig. 14 shows a top view of the active pattern 64 overlying the reference pattern 50. Again, the operator can view the complete vernier through a microscope. The operator looks down at the vernier and sees a view similar to that shown in Fig. 13, but this time there is a misalignment apparent. As shown in Fig. 14 the alignment is off slightly
10 in both the x-axis and the y-axis. The overlapped shapes 112 in the apparent alignment region 110 that is most aligned is two positions up and three positions over from the optimal centered position 116. Each integer shift in the apparent position corresponds to the absolute difference in the reference pitch and the active pitch as discussed above.
15 So for example, if the difference in pitch were 0.05 micrometers, the operator would determine that the misalignment was +0.15 micrometers in the x-direction and -0.10 micrometers in the y-direction. The operator would then confirm whether this was an acceptable misalignment.

 It is thus possible using this two dimensional vernier, for the
20 operator to calculate the level of misalignment in two dimensions simultaneously. Simultaneously as used herein means that no realignment of the microscope to a second vernier is required when taking a reading for two axes of alignment.

25

What is claimed is:

1. A vernier pattern formed on a substrate comprising:
 - a) a first two-dimensional array of spaced shapes having a first distance across each shape and a first distance between adjacent shapes patterned overlying the substrate, wherein the first
5 two-dimensional array has a first pitch defined by the sum of the first distance across each shape and the first distance between adjacent shapes;
 - b) a second two-dimensional array of spaced shapes having a second distance across each shape and a second distance between
10 adjacent shapes patterned with photoresist overlying the first two-dimensional array, wherein the second two-dimensional array has a second pitch defined by the sum of the second distance across each shape and the second distance between adjacent shapes; and
 - c) wherein the second pitch is different then the first
15 pitch.
2. The vernier of claim 1, wherein the first two-dimensional array has an x-axis and a y-axis which are symmetrical to each other.
3. The vernier of claim 1, wherein the first two-dimensional array has an x-axis and a y-axis which are asymmetrical relative to each other.

4. The vernier of claim 1, wherein the first distance across each shape is the same as the second distance across each shape.

5. The vernier of claim 1, wherein the first distance between adjacent shapes is the same as the second distance between adjacent shapes.

6. The vernier of claim 1, further comprising centerline marks.

7. The vernier of claim 1, further comprising negative direction marks.

8. The vernier of claim 1, further comprising positive direction marks.

9. The vernier of claim 1, wherein the first two-dimensional array of spaced shapes is a dark field pattern.

10. The vernier of claim 1, wherein the first two-dimensional array of spaced shapes is a light field pattern.

11. The vernier of claim 1, wherein the second two-dimensional array of spaced shapes is a dark field pattern.

12. The vernier of claim 1, wherein the second two-dimensional array of spaced shapes is a light field pattern.

13. A method of forming a vernier on a substrate comprising the steps of:

- a) forming a reference pattern on the substrate;
- b) depositing a layer of photoresist over the reference
5 pattern; and
- c) patterning the layer of photoresist to produce an active pattern.

14. The method of claim 13, wherein the step of forming a reference pattern further comprises etching a pattern into the silicon substrate.

15. The method of claim 13, wherein the step of forming a reference pattern further comprises depositing a layer of material over the substrate and etching a pattern into the layer of material.

16. The method of claim 13, wherein the step of forming a reference pattern further comprises depositing a layer of material over the substrate and etching a pattern into the layer of material, depositing a metal into the pattern and polishing the metal using CMP to produce a
5 flat reference pattern.

17. The method of claim 13, wherein the step of forming a reference pattern produces a light field pattern.

18. The method of claim 13, wherein the step of forming a reference pattern produces a dark field pattern.

19. The method of claim 13, wherein the step of forming a active pattern produces a light field pattern.

20. The method of claim 13, wherein the step of forming a active pattern produces a dark field pattern.

21. A method of determining misalignment between two patterns formed over a substrate comprising the steps of:

- a) positioning a two dimensional vernier under a microscope;
- 5 b) determining an alignment region;
- c) identifying a pair of overlapped shapes that are most fully aligned; and
- d) ascertaining the position of the pair of overlapped shapes.

22. The method of claim 21, wherein the step of determining the alignment region determines the alignment region in two dimensions simultaneously.

23. The method of claim 21, wherein the step of ascertaining the position of the pair of overlapped shapes ascertains the position in two dimensions simultaneously.

24. The method of claim 21, further comprising a step of calculating a level of misalignment in both dimensions.

25. The method of claim 24, wherein the step of calculating a level of misalignment comprises determining an integer number of shapes from the centerline for a first dimension and multiplying it by a resolution for the first dimension.

26. The method of claim 25, wherein the step of calculating a level of misalignment comprises determining an integer number of shapes from the centerline for a second dimension and multiplying it by a resolution for the second dimension.

ABSTRACT OF THE DISCLOSURE

A two dimensional vernier is provided along with a method of fabrication. The two dimensional vernier has a reference array patterned into a substrate, or a material overlying the substrate. An active array is
5 patterned into photoresist overlying the substrate or the material. Both the reference array and the active array each comprise a two dimensional array of shapes. A difference between a combination of size or spacing of the shapes in each array determines vernier resolution. Vernier range is determined by a combination of vernier resolution and an integer related
10 to a total number of shapes along a given axis. The two dimensional vernier allows an operator to readily measure the misalignment of a pattern to be processed relative to a previous pattern in two dimensions using a microscope. The two dimensional vernier reduces, or eliminates, repositioning of the microscope to determine both x-axis misalignment
15 and y-axis misalignment. If a significant misalignment is detected the photoresist can be stripped and the lithography step repeated prior to subsequent processing, and possible yield reduction.



In Re: Patent Application of Bruce D. Ulrich
Entitled: X/Y Alignment Vernier and Method of Fabricating Same
Attorney Docket SLA 494
Sheet 1 of 7

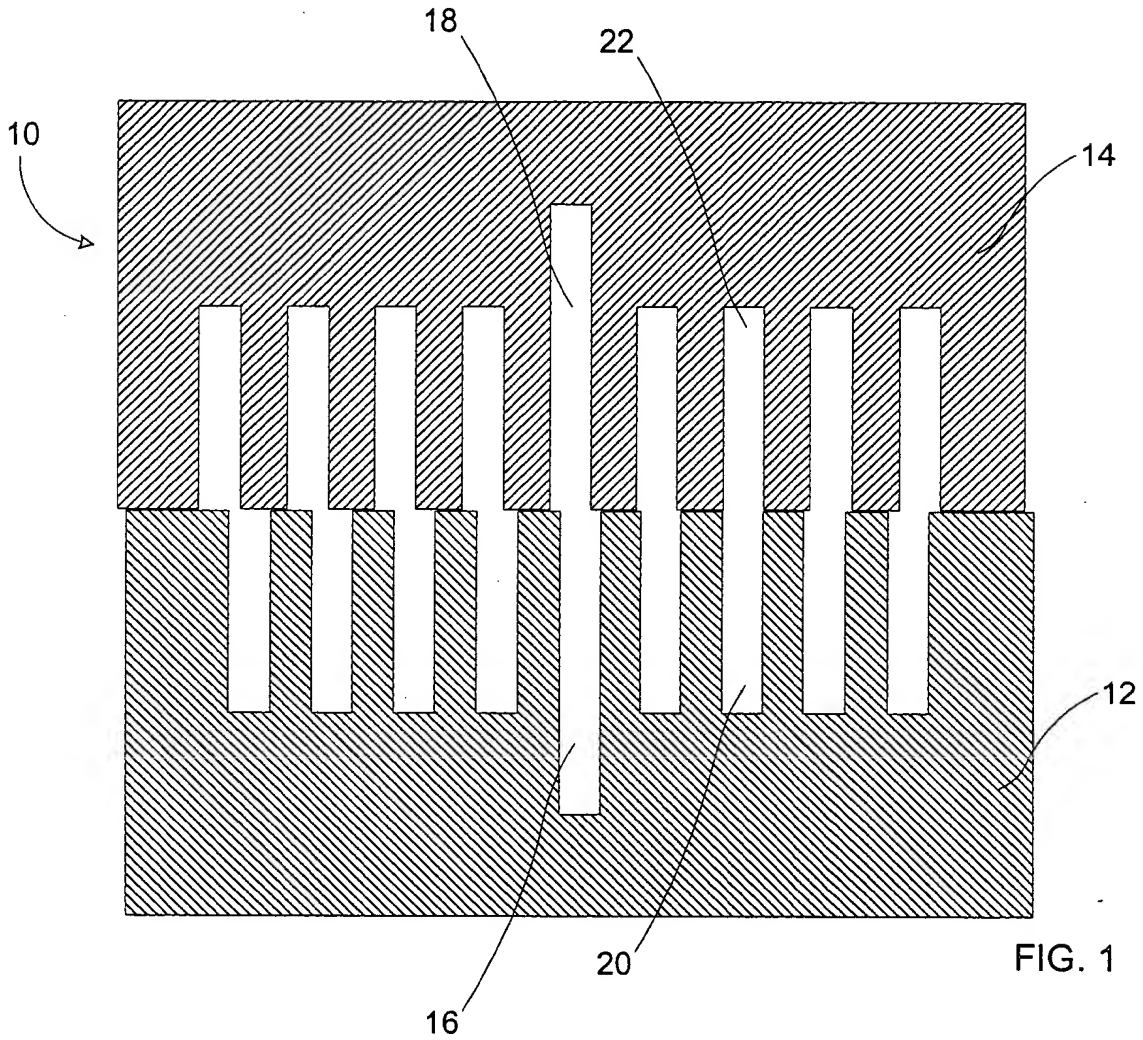
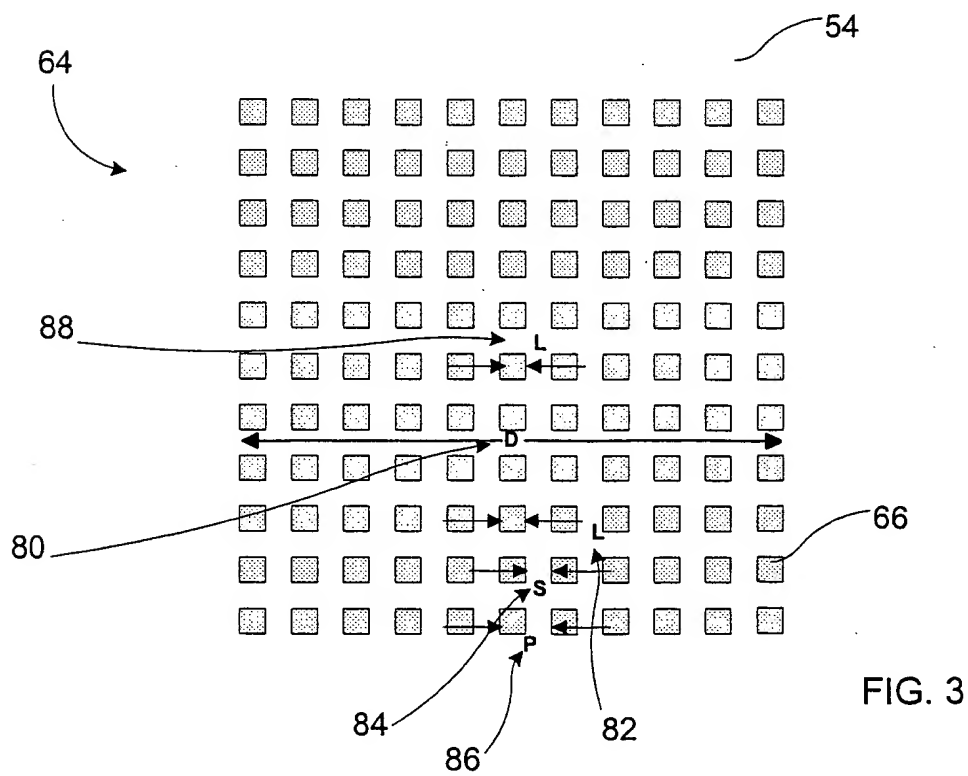
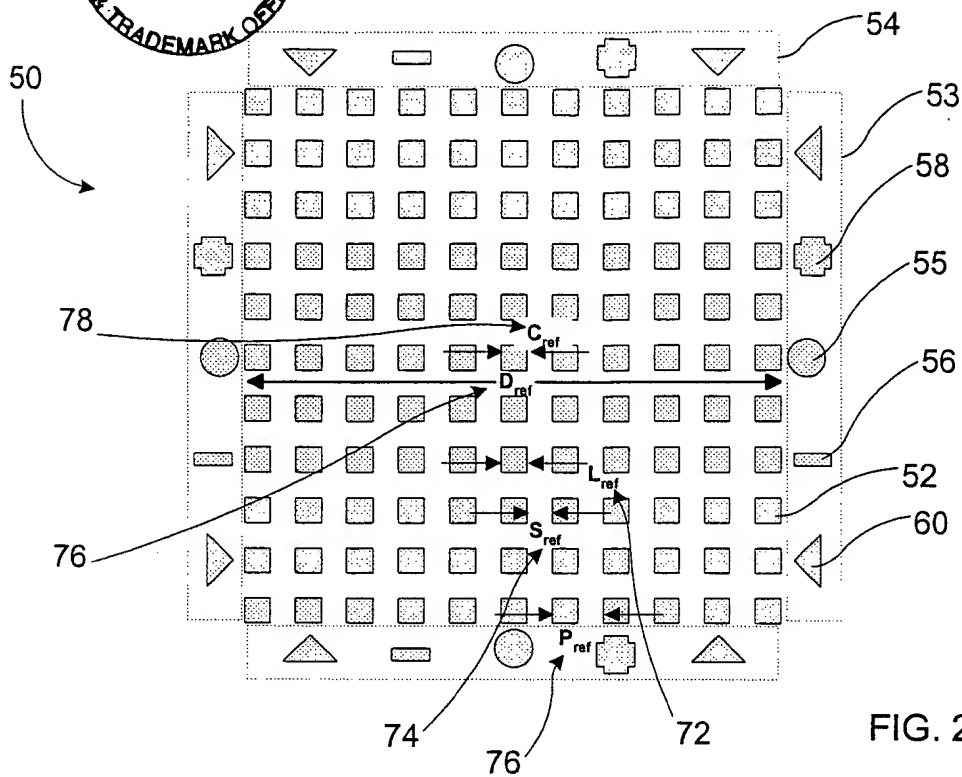


FIG. 1





In Re: Patent Application of Bruce D. Ulrich
Entitled: X/Y Alignment Vernier and Method of Fabricating Same
Attorney Docket SLA 494
Sheet 3 of 7

50

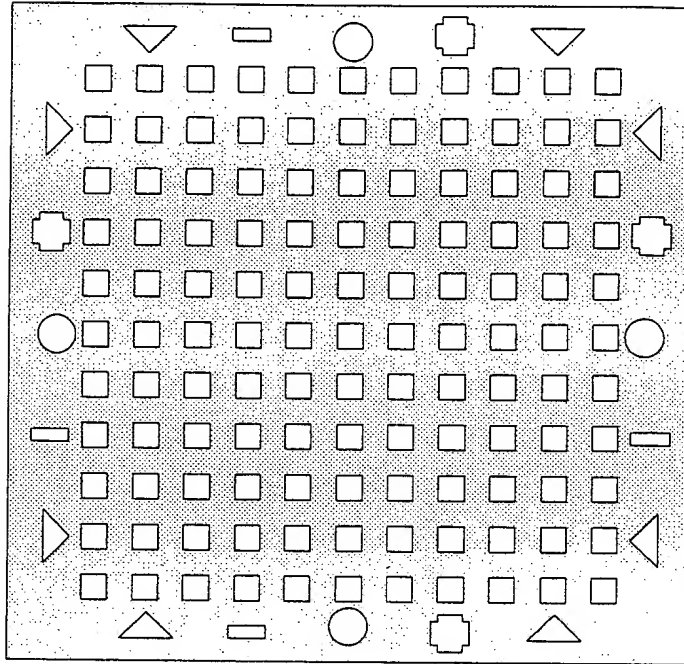


FIG. 4

64

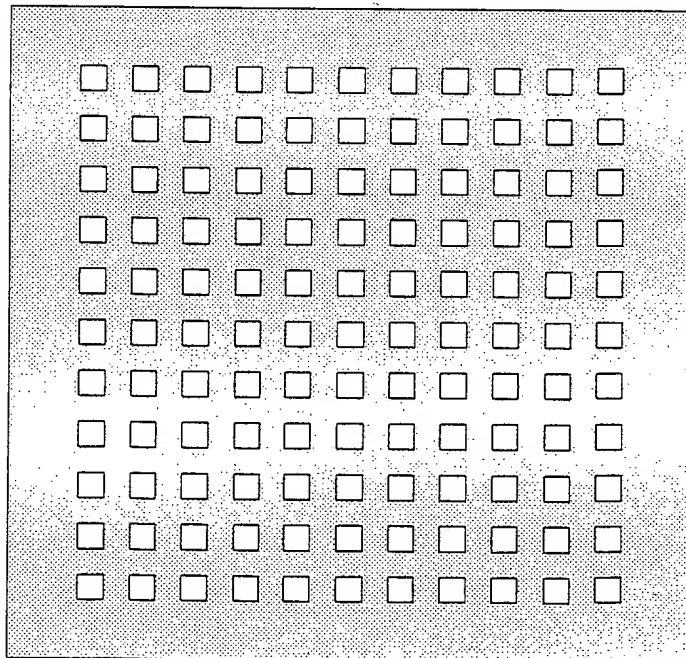


FIG. 5

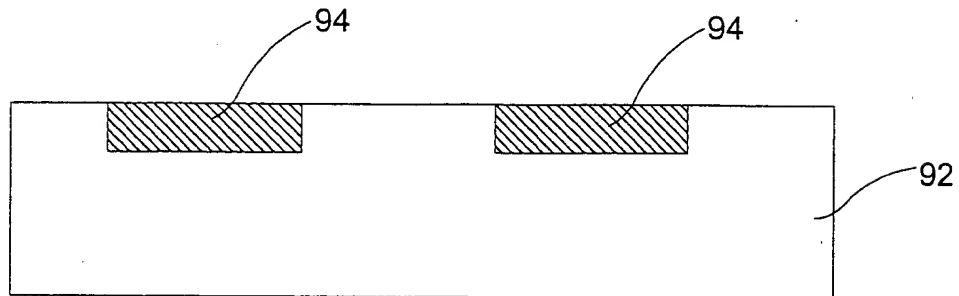


FIG. 6

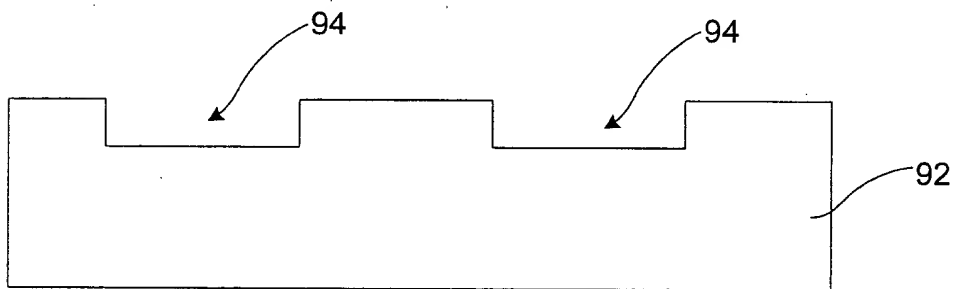


FIG. 7

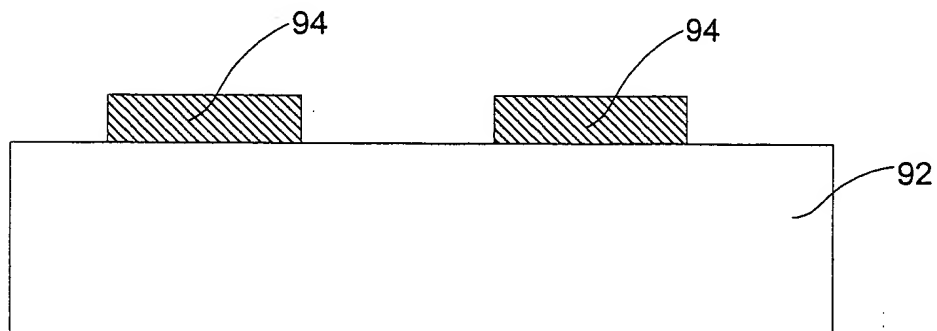


FIG. 8



In Re: Patent Application of Bruce D. Ulrich
Entitled: X/Y Alignment Vernier and Method of Fabricating Same
Attorney Docket SLA 494
Sheet 5 of 7

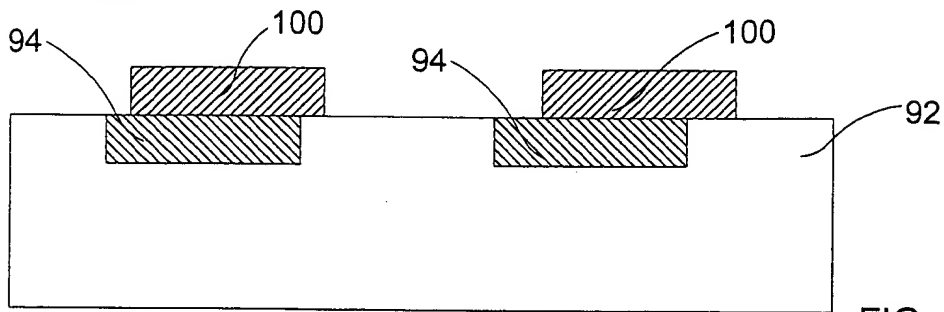


FIG. 9

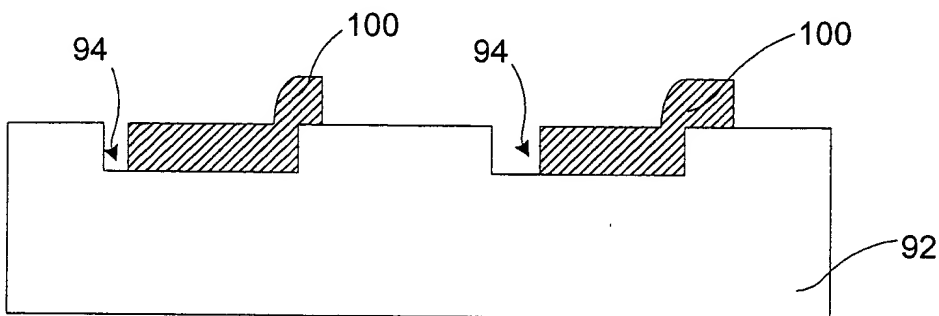


FIG. 10

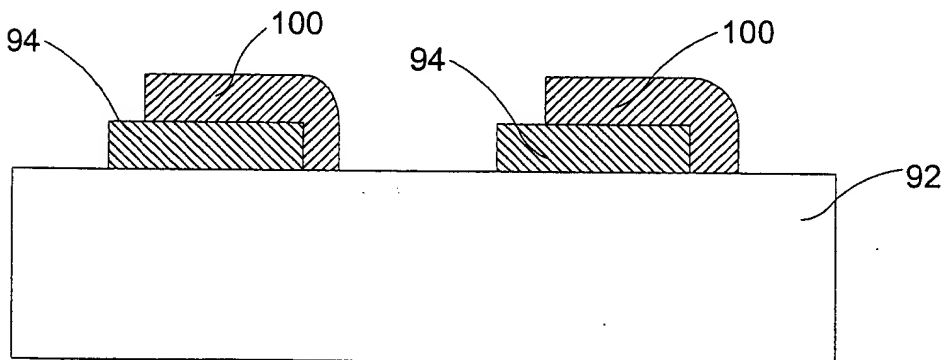


FIG. 11

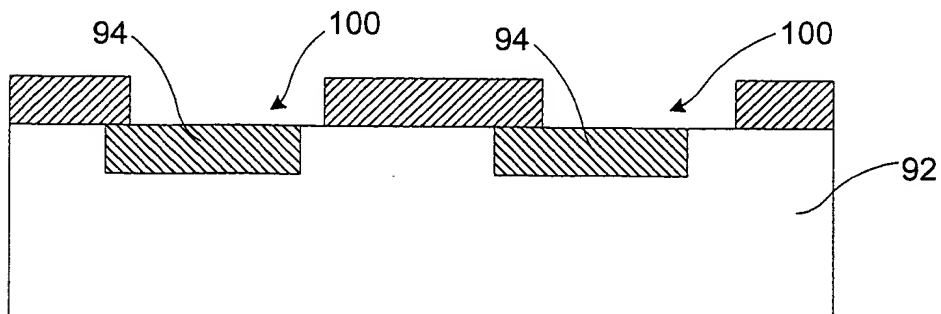


FIG. 12



In Re: Patent Application of Bruce D. Ulrich
Entitled: X/Y Alignment Vernier and Method of Fabricating Same
Attorney Docket SLA 494
Sheet 6 of 7

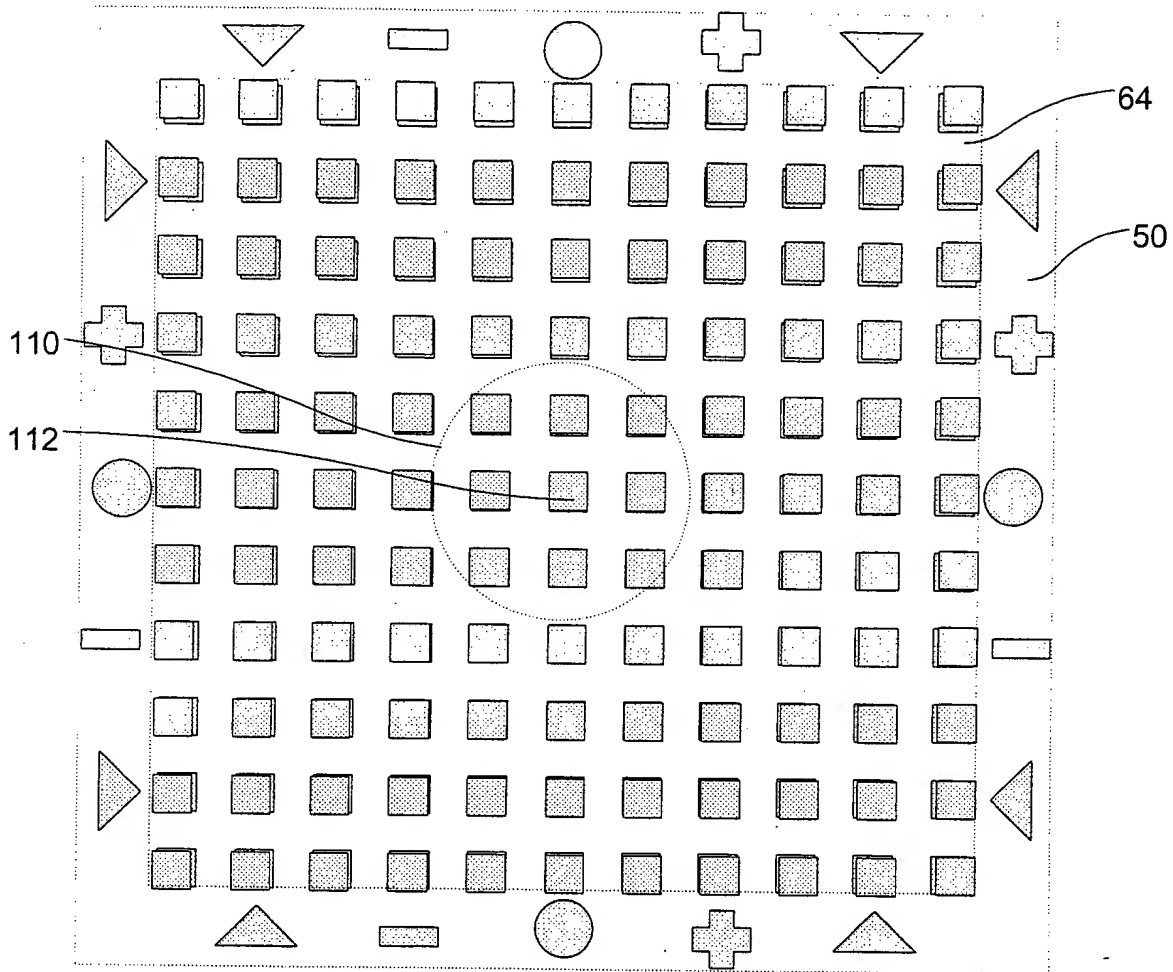


FIG. 13

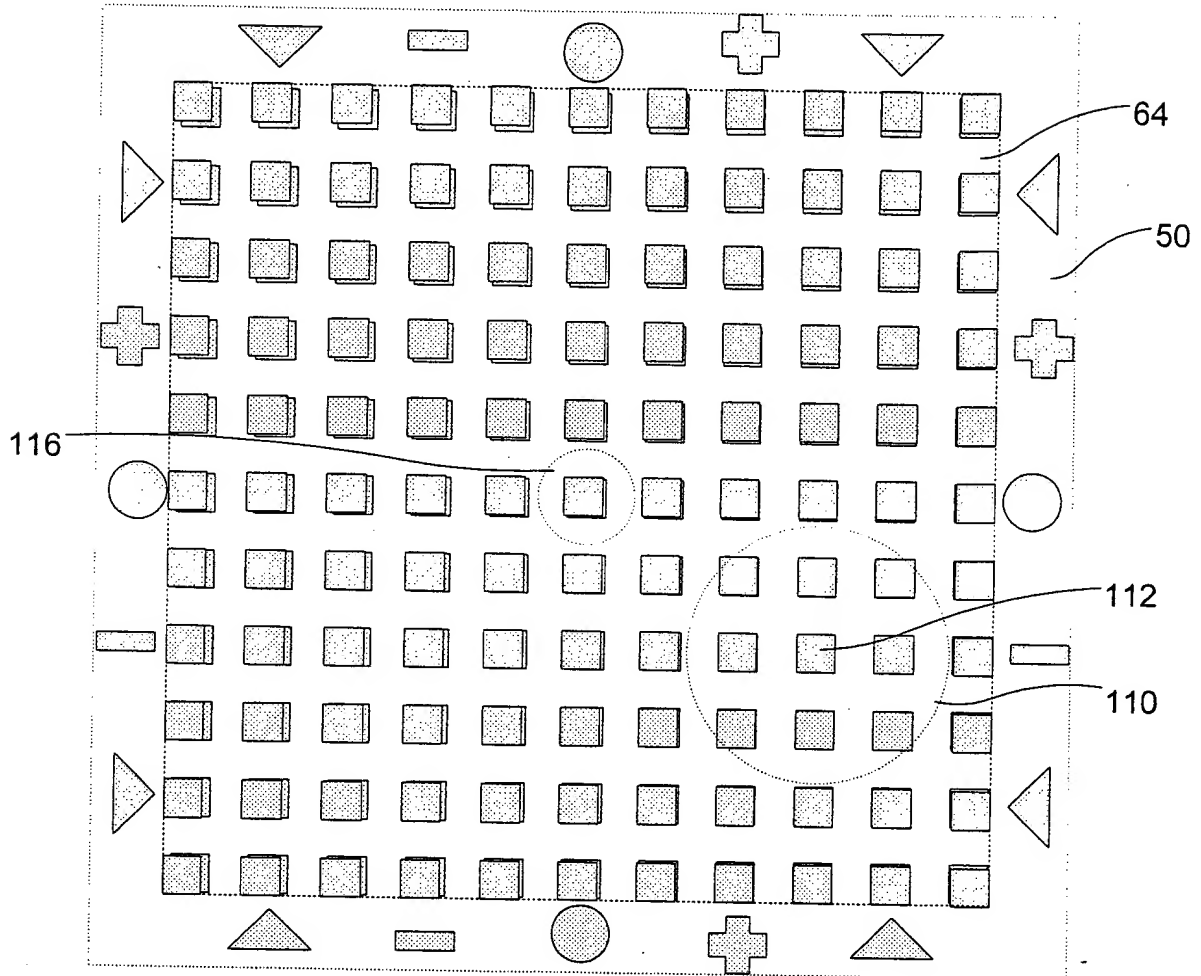


FIG. 13